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EVALUATING SELF-CONTROL AND IMPULSIVITY IN CHILDREN WITH SEVERE BEHAVIOR DISORDERS

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Impulsivity and self-control involve a choice between a smaller, more immediate reinforcer and a larger, more delayed reinforcer. Impulsive behavior occurs when responding produces the more immediate, relatively smaller reinforcers at the expense of delayed larger reinforcers. Self-control occurs when responding produces delayed larger reinforcers at the expense of immediate smaller reinforcers. Recently, researchers in applied behavior analysis have suggested that evaluations of self-control and impulsivity are relevant to socially important behaviors. Further, common behavioral treatments such as differential reinforcement may be influenced by variables such as reinforcer delay. In this study, we showed that aggression, reinforced by access to food, could be maintained as impulsive behavior. The participants were 2 young boys with severe developmental disabilities. For both participants, descriptive observations, care provider report, and functional analyses suggested that aggression was reinforced by food access (and television access for 1 participant). Next, we introduced a differential reinforcement procedure in which appropriate mands were reinforced. After various manipulations, we showed that aggression occurred when it produced immediate but small reinforcers even though mands produced larger, more delayed reinforcers. However, both participants displayed self-control when the delay to reinforcement was signaled (with a hand gesture or a timer).

DESCRIPTORS: self-control, impulsivity, aggression, differential reinforcement

Impulsiveness and self-control involve a choice between a larger, more delayed reinforcer and a smaller, more immediate reinforcer (Jackson & Hackenberg, 1996). Impulsive behavior occurs when responding produces more immediate, relatively smaller reinforcers at the expense of delayed larger reinforcers. Self-control occurs when responding produces larger delayed reinforcers at the expense of immediate smaller reinforcers (Logue, 1995). When laboratory animals are presented with a choice between a small immediate reinforcer and a large delayed reinforcer, they usually behave impulsively by selecting the immediate reinforcer (Ainslie, 1974; Rachlin & Green, 1972).

Humans also appear to engage in impulsive behavior in a variety of situations (Logue, 1995). For example, turning on a television produces immediate reinforcement, but engaging in that response might preclude access to a qualitatively larger reinforcer such as getting a high score on an exam (if television viewing competed with studying). Overeating, drug and alcohol use, failure to exercise, and many other problematic behaviors have been discussed in terms of impulsivity and self-control, because those behaviors produce both immediate and longer term outcomes (e.g., Logue, 1995; Rachlin, 1974). Such conceptualizations seem ap-

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propriate to the extent that much of human operant behavior operates under concurrent reinforcement schedules.

There is a recently increased interest in impulsivity and self-control in applied settings (e.g., Dixon et al., 1998; Fisher, Thompson, Bowman, Hagopian, & Krug, in press). For example, severe behavior disorders displayed by individuals with developmental disabilities can be conceptualized and evaluated from a perspective of concurrent reinforcement schedules (e.g., Fisher & Mazur, 1997). That is, problem behaviors are maintained by one schedule of reinforcement and appropriate alternative behaviors are maintained on some other schedule of reinforcement. If the schedule of reinforcement favors problem behavior over appropriate behavior, more responding is allocated to that schedule; if the schedule of reinforcement favors appropriate behavior, more responding is likely to be allocated to the appropriate behavior schedule (Vollmer, Roane, Ringdahl, & Marcus, 1999). Such an analysis is consistent with the matching law (e.g., Herrnstein & Loveland, 1975). However, to date, no experimental analyses of severe problem behavior have evaluated the effects of providing relatively larger, more delayed reinforcers for one response alternative while relatively smaller, more immediate reinforcers are available for another response alternative.

One approach to evaluating severe behavior problems as impulsive behavior might be to extend laboratory models of impulsivity and self-control. However, experimental preparations demonstrating human behavior as impulsive are difficult to establish. Often, reports of impulsivity in humans are based on nonexperimental methods such as checklists. For instance, Posavac, Sheridan, and Posavac (1999) inferred that a group of children with attention deficit hyperactivity disorder (ADHD) behaved impulsively based on information derived from various checklists and scales, but an experimental test was not conducted. In fact, with few exceptions, despite the fact that impulsivity seems to pervade human behavior, humans frequently engage in self-control rather than impulsive behavior in the laboratory. For example, Logue, Peña-Correal, Rodriguez, and Kabela (1986) provided humans with a choice between an immediate small number of points (exchangeable for money) and a delayed large number of points (exchangeable for money), and the participants most often chose the delayed points. The findings of Logue et al. are consistent with numerous studies showing a general tendency of humans to engage in self-control responses in the laboratory context (e.g., Belke, Pierce, & Powell, 1989; Flora & Pavlik, 1992). Possible exceptions seem to occur with young children (e.g., Schweitzer & Sulzer-Azaroff, 1988); it is important to note that young children and individuals with developmental disabilities may both have a a limited verbal repertoire, which is a common factor associated with impulsivity (Mischel & Mischel, 1983).

Because impulsivity is common in laboratory animals and self-control is common in laboratory studies with humans, Jackson and Hackenberg (1996) outlined possible reasons that humans may tend to maximize the overall obtained reinforcement in laboratory preparations (i.e., engage in self-control) whereas nonhumans do not. Jackson and Hackenberg pointed out that a key procedural difference between human and nonhuman experimentation is that human studies typically involve token reinforcers (e.g., points) whereas nonhuman experimentation involves primary reinforcers (e.g., food). They went on to conduct an experiment using conditioned reinforcers with pigeons and found that self-control choices were made frequently under some circumstances, suggesting that behavior maintained by condi-

tioned reinforcement may be less prone to impulsive choice.

The approach of Jackson and Hackenberg (1996) was to make the procedures used with nonhumans more closely resemble those used with humans to demonstrate self-control in nonhumans. However, the problem of demonstrating impulsivity in humans remains. As the study by Jackson and Hackenberg highlighted, a failure to demonstrate impulsivity may be a function of using token reinforcers in the laboratory. Although the use of token reinforcers may provide an analogue to impulsive behavior in humans in relation to some stimuli (e.g., money), many other behaviors that are not maintained by token reinforcement may be sensitive to an analysis of impulsivity. Consumable reinforcers, but not token reinforcers (e.g., access to food or tangible items), frequently maintain severe behavior problems displayed by individuals with developmental disabilities. Thus, an experimental analysis of severe behavior problems may be useful not only to better understand the behavior problem but also to better understand impulsivity in general.

Often, qualitatively and quantitatively small reinforcers maintain severe behavior problems, presumably because they are delivered immediately contingent on behavior. For example, the literature on the functional analysis of severe behavior disorders shows that many individuals engage in self-injury, aggression, and other problem behavior that is reinforced by a brief reprimand (e.g., Derby et al., 1992; Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994). It is likely that the occurrence of problem behavior reinforced by reprimands precludes longer and qualitatively more valuable social interactions that may have occurred at a later time if problem behavior was not so prevalent. Similarly, escape-maintained behavior is often sensitive to relatively short breaks from instructional activity (e.g., 20 to 30 s), even though occurrences of problem behavior might extend the overall duration of the instructional activity and eliminate a longer break period. In short, under some circumstances problem behavior may be impulsive.

Evaluations of impulsivity and self-control are relevant not only to the functional analysis of severe behavior disorders but also to treatment. Given that differential reinforcement procedures represent concurrent schedules, treatment success may depend on the relative delay to reinforcement for appropriate behavior and inappropriate behavior. For example, Hagopian, Fisher, Sullivan, Acquisto, and LeBlanc (1998) reported that in many cases the effects of differential reinforcement wane when delays to reinforcement are introduced for the desired alternative behavior. However, the notion of self-control and impulsivity as they relate to differential reinforcement is distinct from how those phenomena are tested in typical laboratory contexts. Specifically, whereas the concurrent operants in most laboratory studies are topographically similar, the appropriate and inappropriate behaviors in behavioral treatments involving differential reinforcement are topographically distinct. Thus, the development of assessment techniques related to impulsivity and self-control, behavior disorders, and behavioral treatments may require special considerations. To date, applied studies on delayed reinforcement are typically conducted in the context of differential reinforcement when the inappropriate behavior is placed on extinction. Thus, it is not clear whether the effects of delays (e.g., reduced effectiveness of differential reinforcement) should be viewed as examples of impulsivity.

The primary purpose of this study was to evaluate self-control and impulsivity with 2 boys with developmental disabilities who displayed positively reinforced aggression. Such an analysis could lend further support for the finding that human behavior is at

times impulsive. An impulsivity analysis of aggression could link basic research on choice and applied research on behavior disorders. Although a few laboratory analyses have shown that human behavior can be impulsive (e.g., Navarick, 1982), such demonstrations are rare and have not been extended to socially relevant behaviors. A secondary purpose of this study was to evaluate the effects of signaled delays on impulsive aggression. Numerous authors have described the beneficial effects of signals when delays to reinforcement are introduced during differential reinforcement (e.g., Fisher et al., in press; Hagopian et al., 1998), so it seems important to evaluate how signals influence tolerance to delays when problem behavior is impulsive. In short, understanding the principles underlying reinforcement of aggression as impulsive choice behavior may eventually lead to more effective interventions.

METHOD

Participants and Setting

Participants were 2 boys who had been referred to an inpatient hospital program for the assessment and treatment of severe aggression. Dale was a 9-year-old boy who had been diagnosed with Sotos syndrome and autism and who engaged in severe aggression in the form of hitting, slapping, and pushing others. According to his parents and based on our observations during the first 3 days of his hospitalization, he was frequently aggressive when someone was eating food in his presence, when his parents restricted food, or when the television was turned off while he was watching. He occasionally imitated vocal responses, but generally did not display conventional language. He was able to feed, dress, and bathe himself with verbal prompting and some physical assistance. His parents decided to seek treatment when he began to hurt his mother and younger siblings (he also displayed self-injurious behavior, but that topography was not addressed in this study). Todd was a 9-year-old boy who had been diagnosed with profound mental retardation and who displayed severe aggression in the form of hitting, hair pulling, pushing, and kicking. According to his grandmother and based on observations conducted in the first 3 days of his hospitalization, aggression occurred almost exclusively in the presence of food. He was unable to speak, and he required almost continuous attention and prompting with self-care routines. His elderly grandmother (primary care provider) decided to seek treatment because she could no longer physically tolerate his aggression (he also displayed flopping during self-care routines, but that topography was not addressed in this study).

With rare exceptions, sessions lasted 10 min and were conducted in a hospital therapy room. Sessions were usually conducted 5 days per week, three to seven times per day. The therapy rooms contained a table, a bed, chairs, and materials as needed for sessions.

Data Collection and Interobserver Agreement

Observers were seated behind a one-way observation window and behavior was recorded on laptop computers. *Aggression* was defined as hitting, pushing, kicking, scratching, or hair pulling. *Mands* were defined as lifting a picture card from the table and holding it out in front of the body in the direction of a therapist.

During 18.0% of the functional analysis sessions, a second observer simultaneously but independently scored the participants' aggression. Interobserver agreement calculations involved dividing the 10-min session into 60 intervals (10 s each). The frequency of a target behavior scored by one observer was compared to the frequency observed by a second observer by dividing the smaller

number by the larger number in each 10-s interval and converting to a percentage. The mean percentage agreement was then used as an overall score. Interobserver agreement averaged 98.5% (range for individual sessions, 90% to 100%).

During 22.5% of all subsequent sessions, a second observer simultaneously but independently scored aggression and mands. For aggression, interobserver agreement averaged 97.5% (range for individual sessions, 86% to 100%). For mands, agreement averaged 97.6% (range for individual sessions, 93% to 100%).

Preliminary Information

Preliminary interviews with Todd's grandmother indicated that she encountered aggression almost exclusively when she was attempting to eat a snack or meal. She reported that Todd became so violent that she had to give him some of the food in order "to get away from him." In addition, we conducted an extensive descriptive analysis and saw virtually no severe aggression except during one observation session when we asked Todd's grandmother to bring food (potato chips) into the room. In that session, Todd's aggression became so severe that we terminated the observation after less than 1 min, in order to intervene and protect his grandmother.

Preliminary interviews with Dale's parents indicated that aggression occurred when access to preferred items, activities, or materials was restricted. Reportedly the two most common situations involved restricted access to food and television (videotapes). Dale had a history of obesity and dietary restrictions, so his parents had purchased locks to secure food in his home. At times, he displayed severe aggression toward his mother and younger siblings until he was given access to food. Due to the severity of Dale's aggression, we simulated conditions involving a television and food only briefly with his mother during descriptive observations.

Functional Analysis

Functional analysis procedures were based on those of Iwata et al. (1982/1994). Therapists used protective equipment, such as arm guards and thick shirts, at their discretion. Three test conditions were conducted: attention, escape, and materials (food for Todd, food and television access for Dale). A fourth condition was designed as a control. During the attention condition, the participant had access to various materials but did not have access to attention unless aggression occurred. A therapist pretended to engage in paperwork or reading. Instances of aggression were to be followed by a brief reprimand and statement of concern (no aggression ever occurred in this condition for either participant). During the escape condition, a therapist presented instructions to perform a self-care task. The instructions were presented about once per 30 s using a three-prompt sequence (verbal, gestural, physical guidance, with 5 s between prompts). Contingent on aggression, a 30-s escape period was allowed. During the materials condition, Todd was given a few potato or corn chips and then the bag of chips was held away from him. Contingent on aggression, he was given one chip. The materials sessions for Dale were similar to those for Todd except that one spoon of low-fat yogurt was used. In addition, some materials sessions involved allowing him to watch a preferred videotape prior to the session. The session began with a therapist turning off the television and then turning it back on for 30 s contingent on aggression. During the control condition, the participants had access to preferred materials (e.g., snacks, television) and attention continuously throughout the session, and no instructional demands were presented.

Impulsivity Analysis

Overview. The impulsivity analysis was conducted in four phases. First was functional communication training (FCT), which was evaluated in a reversal design. Second was FCT with delay, which was evaluated using a concurrent-schedules format. Third was a reinforcer magnitude evaluation, which was evaluated in a concurrent-schedules format. Fourth was an impulsivity test, which was conducted in a combined concurrent-schedules and multielement design.

Phase 1: FCT. The purpose of this condition was to establish a behavior (i.e., a mand) that was functionally equivalent to aggression (Carr & Durand, 1985). Baseline was the last five sessions (Todd) or six sessions (Dale) of the materials condition in the functional analysis. Prior to FCT conditions, each participant was physically guided through the mand response (handing a therapist a picture card). For both participants, acquisition of the mand occurred rapidly (within 5 min); our purpose was not to demonstrate acquisition of mands, but rather to show that they served the same function as aggression. During FCT conditions, mands were reinforced with access to one chip (Todd), one spoon of yogurt (in some sessions for Dale), or 30 s of television access (in other sessions for Dale). Also during FCT, all aggression was placed on extinction (i.e., it did not produce access to food or television). A brief reversal to baseline for both participants involved a replication of initial baseline procedures.

Phase 2: FCT with delay. The purpose of this condition was to establish whether the mands could be maintained with a 10-s delay to reinforcement. If so, the participant would be eligible for a subsequent impulsivity test. As pointed out by Navarick (1996), if a behavior is not sensitive to delayed reinforcement, any responding on alternative (immediate reinforcement) choices cannot be presumed to be impulsive; it may be that there is no functional reinforcement available for the delayed reinforcement alternative. For Todd, a therapist entered the room once per minute. If Todd handed the therapist a picture card, he received food after a 10-s delay. The therapist left the room after reinforcer deliveries or after 50 s (to set up the next trial). If he was aggressive, he received no food. For Dale, a therapist stayed in the room throughout the session. At any time, if Dale handed the therapist a card, he received one bite of yogurt (in some sessions) or 30-s access to television (in other sessions) after a 10-s delay. Aggression was placed on extinction (it did not produce access to food or television). Using different procedures for Todd and Dale allowed us to evaluate delayed reinforcement effects with both a discrete-trial (Todd) and free-operant (Dale) arrangement. For both participants, if rates of mands, which produced delayed access to material reinforcers, were maintained at levels consistently higher than aggression (which was not reinforced), it can be concluded that access to materials reinforced mands despite the delay to reinforcement.

Phase 3: Reinforcer magnitude test. Before testing for impulsivity, it is essential to test for behavioral sensitivity to differential magnitudes of reinforcement at equal delays (Rachlin & Green, 1972). In other words, it must be demonstrated that, when arranged against a smaller amount of a reinforcer in a concurrent-schedules arrangement, more responding will be allocated to the larger amount of the reinforcer. For Todd, in this condition aggression produced access to one chip and mands produced access to three chips. Thus, on any given trial he could choose either the larger reinforcer by emitting a mand or a smaller reinforcer by engaging in aggression. Trials were conducted at 1-min intervals. For Dale, aggression produced access to one spoon of yogurt

(or 30-s access to television in some sessions) and mands produced two spoons of yogurt (or 60-s access to television). For Dale, trials were not separated by time intervals, so the choice procedure represented a concurrent free-operant comparison. That is, at any given moment he could choose either the larger reinforcer by emitting a mand or a smaller reinforcer by engaging in aggression; both responses were immediately reinforced.

Phase 4: Impulsivity test. For Todd, a therapist came into the room once per minute. By having a therapist enter the room once per minute, the overall rate of trials was held constant so that aggression could not result in an overall higher density of food (Rachlin & Green, 1972). Aggression produced immediate access to one chip. Mands produced delayed access (10 s) to three chips. Any aggression that occurred during the delay interval after a mand produced immediate access to one chip and no reinforcement for the mand. Given that we already knew (from Phases 2 and 3) that Todd's mands could be reinforced despite a delay and that access to three chips was a stronger reinforcer than access to one chip, any aggressive responses would be impulsive (including mand plus aggression) and any mand (except mand plus aggression) would be self-control, by definition. In addition, we evaluated the effects of signaling the delay to reinforcement in the context of a multielement design. In the unsignaled delay condition, the therapist stood still for 10 s after a mand and then delivered three chips. In the signaled delay condition, the therapist placed his or her hand in the chip bag and held it there for the duration of the 10-s delay.

For Dale, initially a therapist came into the room once per minute to control overall reinforcement density. Aggression produced immediate access to one spoon of yogurt (or 30-s access to television). Mands produced two spoons of yogurt (or 60-s access to television) following a brief delay (the delay value increased across sessions). Aggression that occurred during the delay interval following a mand produced the immediate reinforcer and no reinforcer for the mand, and was therefore considered impulsive. Thus, procedures were similar to those used with Todd, but with two exceptions. The first difference was that the signaled delay condition involved a digital timer placed in Dale's view rather than a hand signal from the therapist. That is, in the unsignaled delay condition the therapist stood still during the delay. In the signaled delay condition, he or she started a timer and placed it directly in front of Dale on a table. The second difference was that, unlike Todd's evaluation, for Dale the delay to reinforcement was gradually increased to 10 min. When the delay to reinforcement was increased beyond 40 s, trials were separated by time intervals longer than 1 min, to accommodate the longer delays. For example, at 2-min delays, the therapist came into the room to begin a new trial once every 3 min. However, 10 trials were always conducted in each session (thus, sessions became longer than 10 min).

RESULTS

Functional Analysis

Figure 1 shows the results of the functional analyses. Although neither Todd nor Dale immediately showed high rates of aggression in the materials condition, differentially high rates did emerge. These results confirmed our hypotheses generated by care provider interviews and brief observations of care provider–child interactions: In both cases, aggression was reinforced by access to material items. Although it is possible to interpret the functional analysis results as cases of "acquisition" of aggression, it should be pointed out that both children had been referred for treatment because they became aggressive in restricted access contexts. Because the therapists were novel

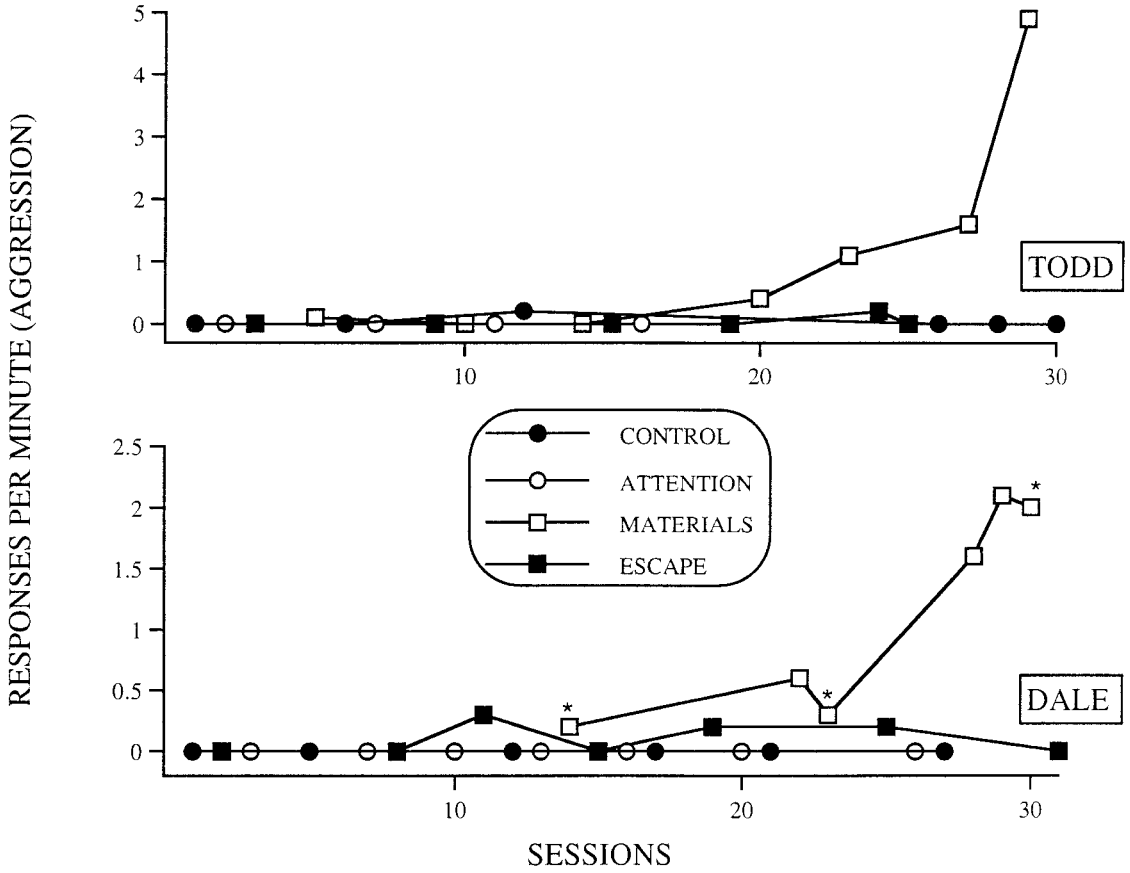

Figure 1. Results of the functional analysis for both participants. For Todd (upper panel), aggression was sensitive to food reinforcement (materials condition). For Dale (lower panel), aggression was sensitive to positive reinforcement in the form of food and television access. Sessions in which television access was tested are marked with an asterisk.

care providers, it is likely that the participants' behavior required some time to come into contact with previously existing reinforcement contingencies.

Two aspects of Dale's assessment warrant additional comment. First, the materials sessions are not depicted in Figure 1 until Session 13. Some materials sessions using toys were briefly probed prior to the assessment, but aggression was not observed. It was not until Session 13 that we were able (a) to obtain a television set with a secure casing and (b) to obtain medical consent to use food reinforcers (because of Dale's history of obsesity). Second, three consecutive materials sessions were conducted toward the end of the assessment. Before that stage of the assessment, two data analysis techniques (coupled with the prior descriptive observations) had already indicated that aggression was responsive to materials as reinforcement: (a) After three materials sessions, a test-control comparison between materials and play showed clear differentiation in the data paths, and (b) within-session response patterns showed a clear reinforcement effect for materials. The final seven sessions of the assessment were conducted only as additional support for the conclusions derived from the earlier portion of the assessment.

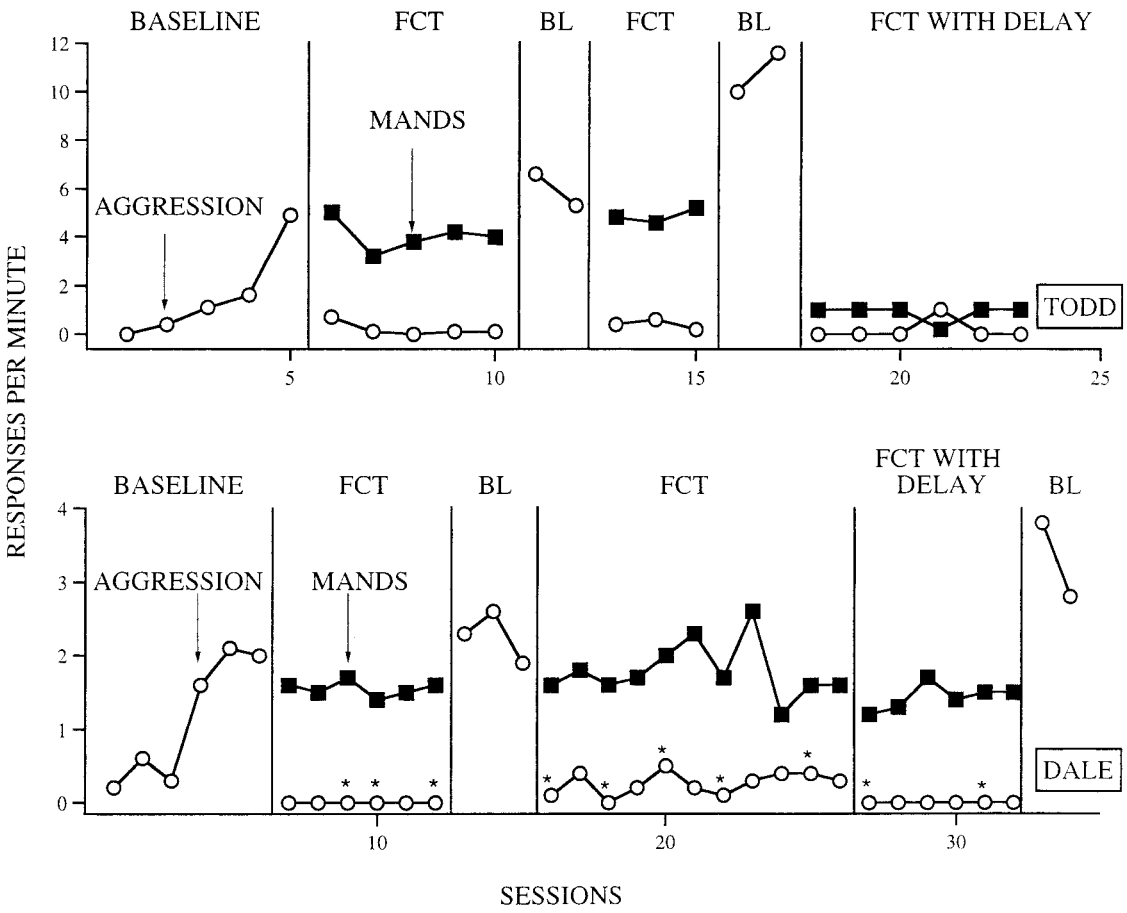

Figure 2. Results of functional communication training (FCT) and FCT with delay for both participants. For Dale (lower panel), sessions involving television access are marked with an asterisk.

FCT (Phase 1) and FCT with Delay (Phase 2)

Figure 2 shows the results of FCT and FCT with delay. For Todd, mands occurred at high rates and aggression occurred at low rates during both FCT conditions. Brief reversals to baseline, during which aggression was reinforced, resulted in high rates of aggression. During the FCT with delay condition, mands were maintained at the maximum rate (one response per minute) in five of the six sessions, showing that mands could be maintained with a delay to reinforcement. The maximum rate of mands was one response per minute because trials were spaced by 1 min.

For Dale, results of FCT were similar to those for Todd. During the FCT with delay, the mand was maintained with a 10-s delay to reinforcement. During the FCT with delay, mand rates were higher than one per minute because Dale's therapist was not using the one trial per minute procedure at this stage (the therapist stayed in the room). Because Dale was not engaging in any aggression at this point, this phase ended with a return to baseline. A return to baseline helped to control for sequence effects in the ensuing reinforcer magnitude test.

Reinforcer Magnitude Test (Phase 3)

Figure 3 shows that both participants' behavior was sensitive to differences in rein-

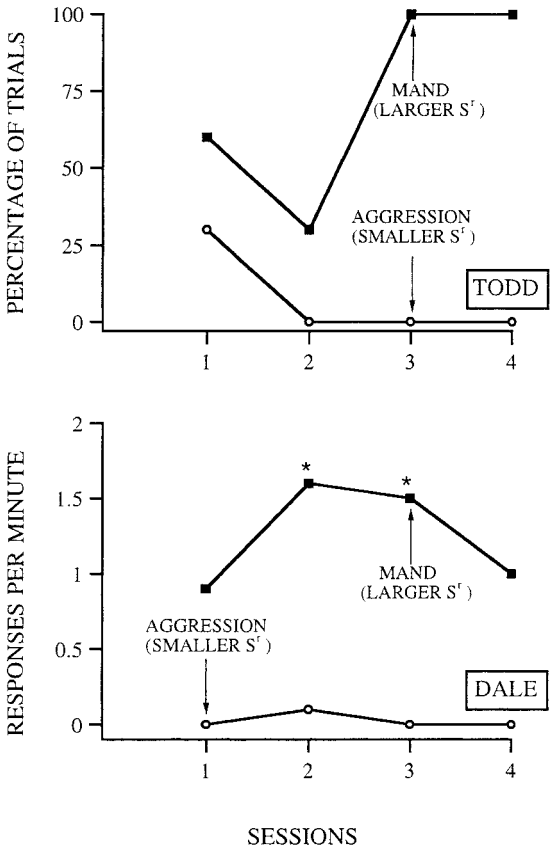

Figure 3. Results of the reinforcer magnitude test for both participants. For Dale (lower panel) sessions involving television access are marked with an asterisk.

forcer magnitude. Todd more frequently chose the mand, which produced three chips, over aggression, which produced one chip at equal delays (0-s delay). The percentage of trials does not sum to 100% in Session 1 or 2 because he sometimes engaged in neither behavior. Dale more frequently chose the mand, which produced two spoons of yogurt (in Sessions 1 and 4) or 60 s of television (in Sessions 2 and 3), over aggression, which produced one spoon of food or 30 s of television.

Impulsivity Test (Phase 4)

Figure 4 shows that both participants behaved impulsively (were aggressive) during a high proportion of trials in the unsignaled delay condition. For Todd, the delay to the larger reinforcer contingent on mands was held constant at 10 s. When the delay to the larger reinforcer was signaled (by the therapist's hand signal), Todd was less likely to behave impulsively, although he did so in some trials. For Dale, the delay to the larger reinforcer contingent on mands was gradually increased to 10 min. When the delay to the larger reinforcer was signaled (via digital timer), he was less likely to behave impulsively, although he did so on a small percentage of sessions.

Figure 5 shows that both participants engaged in the self-control response (mand) during a relatively high proportion of the trials in the signaled delay condition. Thus, the low levels of impulsivity obtained during the signaled delay condition (see Figure 4) were not a result of generally low levels of behavior. Rather, both participants engaged in mands and waited the duration of the delay without aggression in most trials when delays were signaled. Conversely, in the unsignaled delay condition, both participants typically engaged in a mand and then engaged in aggression during the delay to reinforcement (an impulsive response that produced immediate access to relatively small reinforcers).

DISCUSSION

Two participants who displayed severe aggression participated in an analysis of impulsivity and self-control. After background information about the aggression was obtained, a functional analysis showed that aggression was maintained by access to tangible reinforcers. Todd's aggression was maintained by food access, and Dale's aggression was maintained by both food and television access. For both participants an FCT analysis showed that appropriate mands were also sensitive to positive reinforcement. For both participants it was demonstrated that mands could be maintained by delayed pos-

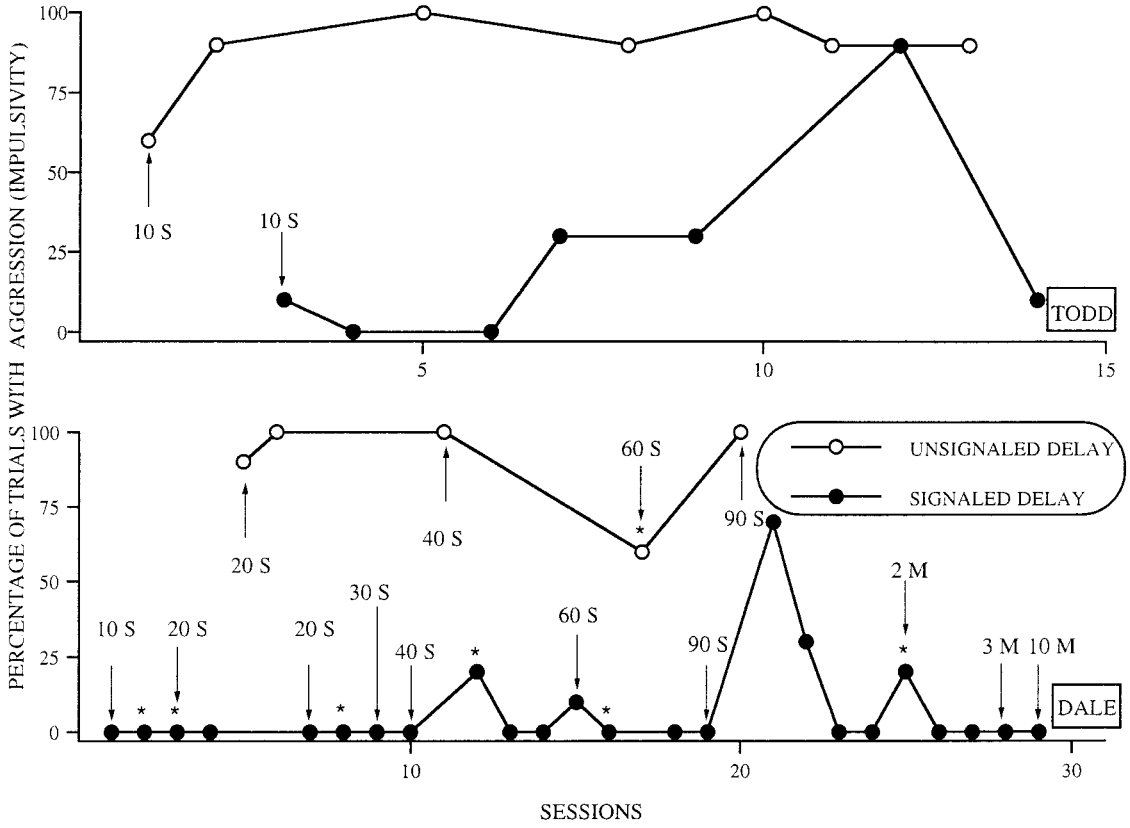

Figure 4. Percentage of trials with aggression (impulsivity) during the impulsivity test for both participants. Open symbols represent sessions in which the delay to reinforcement for mands was unsignaled. Closed symbols represent sessions in which the delay to reinforcement for mands was signaled. For Dale (lower panel), sessions involving television access are marked with an asterisk.

itive reinforcement. Also, for both participants it was demonstrated that mands occurred more frequently than aggression when both operants produced immediate reinforcers but mands produced quantitatively greater reinforcement. Finally, for both participants it was demonstrated that aggression occurred more frequently than mands under unsignaled delay conditions, when aggression produced a smaller, more immediate reinforcer in comparison to mands. That is, under unsignaled delay conditions, aggression was an impulsive behavior. Conversely, under signaled delay conditions, both participants displayed self-control by engaging in mands, which produced a relatively larger, more delayed reinforcer.

The procedures used in this study provide a format for evaluating impulsivity and self-control in relation to severe behavior disorders. Under many circumstances severe problem behaviors (such as aggression) are maintained by positive reinforcement even though reinforcers are available for an alternative behavior (such as mands). One way that the schedule of reinforcement for alternative behavior may become less favorable is if reinforcer delivery is relatively delayed. The assessment procedures used in this study confirm that delays to reinforcement might undermine treatment attempts if problem behavior continues to receive reinforcement.

We do not wish to speculate that the re-

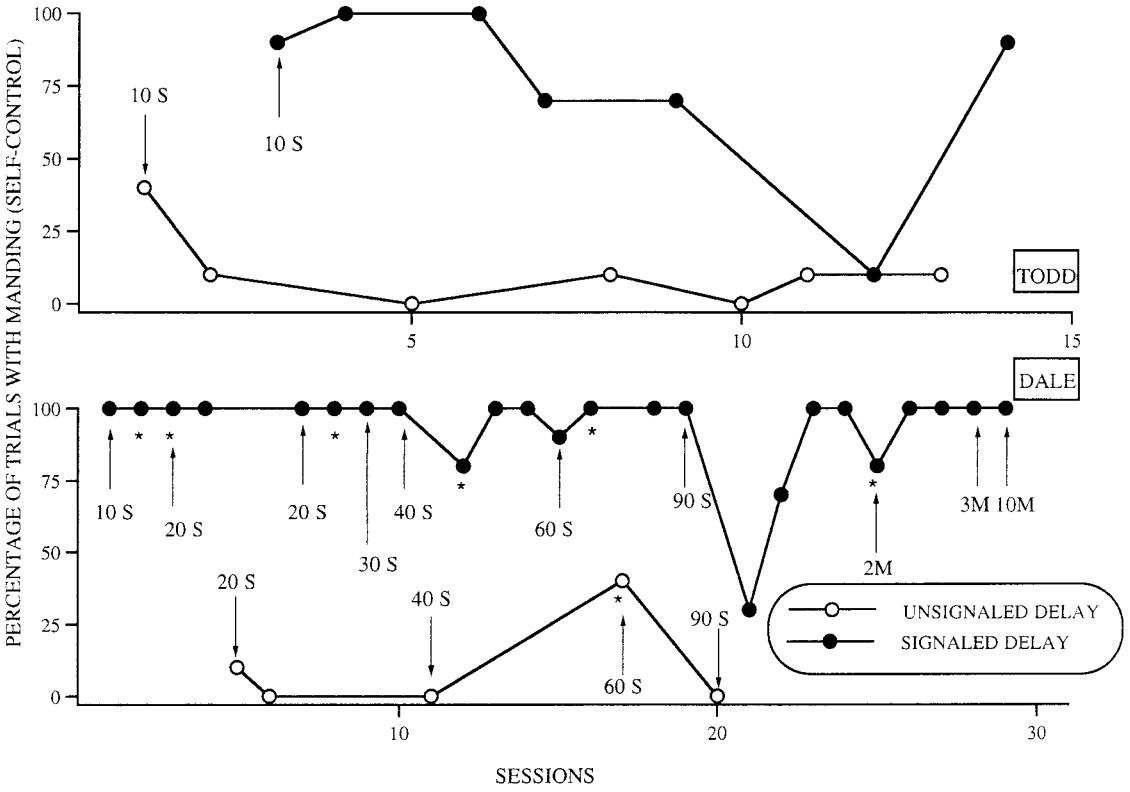

Figure 5. Percentage of trials with manding (self-control). Open symbols represent sessions in which the delay to reinforcement for mands was unsignaled. Closed symbols represent sessions in which the delay to reinforcement for mands was signaled. For Dale (lower panel), sessions involving television access are marked with an asterisk.

lations demonstrated for Todd and Dale corresponded to the actual concurrent schedules of reinforcement in their natural environments; in fact, because the participants did not previously use picture cards to request items, it is very unlikely that such relations existed. However, it is important to recognize that the participants' behavior was sensitive to contingencies of reinforcement that reflect impulsivity. This finding is significant for at least two reasons: (a) It provides empirical support for the conceptualization of human behavior as impulsive under some circumstances, and (b) it may provide information that will prove to be useful for treatment development.

One principal limitation of the study was that no treatment evaluation was conducted outside of an analogue setting, so it is not clear exactly how an evaluation of impulsivity might lead to more effective treatment. However, the finding that signaled delays were effective in reducing impulsive responses suggests one avenue of treatment: Delays to reinforcement should be signaled (e.g., Fisher et al., in press). For Dale, the delay to reinforcement was extended to 10 min when the digital timer was used as a signal. Although it was not evaluated in this study, Dale's eventual treatment package involved the use of a digital timer contingent on requests for materials that were temporarily unavailable (e.g., a television while riding in the car or food between mealtimes).

To make the delay condition more natural, future studies could evaluate the effects

of signal fading or briefly signaled delays. Signal fading could involve gradually eliminating the signal from an increasing number of trials, such that eventually self-control might occur in the absence of the signal. Briefly signaled delays, such as a verbal statement (e.g., "please wait"), might be a more acceptable signal than the signals used in this study (Fisher et al., in press). Laboratory research suggests that briefly signaled delays can be as effective as signals that remain on throughout the duration of the delay. Schaal, Schuh, and Branch (1992), for example, showed that a brief color change on a keylight, correlated with a delay to reinforcement, supported key pecking in pigeons. To extend these findings to the assessment of severe behavior disorders, an experimental comparison could be conducted between briefly signaled (e.g., "wait please") and signaled (e.g., timer on throughout the delay interval) delays, perhaps in a format similar to the current study, in which signaled and unsignaled delays were compared.

Parametric manipulations of the reinforcer magnitudes and delays might result in differential sensitivities to immediate reinforcement. For example, Todd may have been less likely to engage in impulsive behavior if the delayed reinforcer was an entire bowl of chips rather than just three chips. Similarly, if the delay to reinforcement was very short for the larger reinforcer (e.g., 3 s), it is possible that one or both participants would have displayed self-control even in the unsignaled condition. Thus, it should not be inferred that so-called "self-control" is something inherent to the individual; rather, specific parameters of delay and reinforcer magnitude are likely to generate impulsivity or self-control. The findings of this study show only that aggression can be maintained as impulsive behavior, not that it *is* an impulsive behavior. Presumably, contingencies may have been arranged such that aggression would have been the self-control response and mands would have been the impulsive response. Such a reversal of contingencies in future studies would strengthen the experimental analysis of impulsivity reported here.

In addition to its proposed utility for development of behavioral interventions, the format used in this study for evaluating impulsivity may serve as an appropriate assessment for a variety of pharmacological interventions. For example, the medication methylphenidate is used in some cases, ostensibly to reduce impulsivity. The unsignaled delay condition in the impulsivity analysis seems well suited as a baseline from which to evaluate methylphenidate (or other drug) effects. If methylphenidate reduces impulsivity (or, conversely, establishes self-control), the appropriate alternative behavior should be more likely to occur in a medication condition than in a placebo control condition. Such analyses may be especially pertinent because many children are diagnosed with ADHD in part as a result of so-called impulse control difficulties and are subsequently treated with stimulant medication (Posavac et al., 1999).

A possible alternative explanation for the data in this study is that the putative impulsivity shown in the unsignaled delay condition merely represents a bias toward the aggressive behavior. However, several facets of the data argue against such an interpretation. First, during the functional analysis and FCT analysis, the participants engaged in the behavior that was currently reinforced (aggression or mands). Second, in the reinforcer magnitude phase, responding was clearly allocated to the mands, which produced the same (larger) amount of the reinforcer eventually arranged against the small immediate reinforcer in the impulsivity test. Third, both participants characteristically manded first and then displayed aggression during the impulsivity analysis, suggesting that if any bias existed, it was toward the use of mands rather than aggression. As

such, it is unlikely that aggression occurred in the unsignaled condition solely as a function of response bias. Rather, the immediacy of the reinforcement contingent on aggression probably accounts for its occurrence.

Several procedural modifications could be made in future research to further strengthen an impulsivity interpretation. First, the immediate and delayed reinforcement contingencies for mands and aggression could be reversed. If mands respond to impulsive reinforcement contingencies under unsignaled conditions, a more convincing argument could be made that responding is controlled by features of the concurrent arrangement (i.e., relative delays) rather than by some idiosyncratic features of the different response topographies. Second, the same response (e.g., mands) could be reinforced on both delayed and immediate reinforcement schedules, correlated with distinct discriminative stimuli, in order to show that there is a preference for immediate reinforcement when response topography is held constant. Third, both response topographies (mands and aggression) could be reinforced with equal delays to ensure that no biases exist prior to introducing a delay (Vollmer et al., 1999).

The procedures used in this study may have utility for basic as well as applied preparations to study impulsivity. Jackson and Hackenberg (1996) posited that the failure to demonstrate impulsivity in most studies with humans probably could be accounted for by a significant procedural difference in human and nonhuman studies: The use of token reinforcement. Jackson and Hackenberg made the reinforcement in the pigeon study more similar to that used with humans (by using conditioned reinforcers). In this study, the opposite was done: Consumable (tangible) reinforcers were presented contingent on the two response alternatives. As such, individuals with developmental disabilities and severe behavior disorders may prove to be apt participants for studies designed to evaluate the basic processes that underlie impulsivity and self-control.

The contribution of this study, then, probably is best described as the development of an experimental preparation that may eventually be used to evaluate impulsive behavior problems, to evaluate behavioral and pharmacological treatments, and to better evaluate basic reinforcement processes in humans. The extent to which such preparations will actually lead to more effective treatments remains unknown. Finally, additional controls are needed in future research to ensure that the observed relations represent examples of self-control and impulsivity.

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STUDY QUESTIONS

1. What response characteristics have often been used to distinguish between behavior that is said to reflect impulsivity and that which is considered to be self-control?

2. How are the concepts of impulsivity and self-control relevant to the analysis of behavior disorders?

3. Rates of aggression for both participants showed an increasing trend in the materials condition of the functional analysis, which were suggestive of response acquisition rather than maintenance. What information did the authors provide to argue against a claim that participants "learned" to be aggressive as a result of participating in the assessment? What other features of the data are inconsistent with an acquisition function?

4. Describe the procedures in effect during the FCT, FCT with delay, and reinforcer magnitude test conditions.

5. Why were the delay and magnitude test conditions important prerequisites to the analysis of aggression as impulsive behavior?

6. How was the impulsivity test conducted, and what results were obtained?

7. What was the authors' general conclusion about the extent to which aggression should be viewed as impulsive behavior?

8. What treatment implications are suggested by the results of the study?

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